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MOVEMENT AND SPRING SPAWNING STUDY

OLDMAN RIVER DAM
ENVIRONMENTAL MITIGATION/OPPORTUNITIES PLAN

BEAK ASSOCIATES CONSULTING LTD.

MOVEMENT AND SPRING SPAWNING STUDY

OLDMAN RIVER DAM ENVIRONMENTAL MITIGATION/OPPORTUNITIES PLAN

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1.0 INTRODUCTION

With the announcement in 1984 of construction of a dam on the Oldman River, the Government of Alberta undertook to determine all feasible means of reducing and mitigating project impacts on the natural environment. The eventual reservoir will potentially inundate approximately 17.5 km of the Oldman River mainstem, 9.5 km of the Castle River, and 6.5 km of the Crowsnest River (Figure 1) and will cover an area of about 2300 ha (Allen 1985). The discharge regime from the dam will affect the Oldman River mainstem downstream to the LNID weir, and depending on the operation of both the dam and LNID weir, will affect flows as far downstream as Fort MacLeod or beyond. Two direct impacts of such a project will be to interfere with normal movement patterns of fish past the dam site, and to inundate sections of spawning and rearing habitat on the lower Castle and Crowsnest Rivers and on the Oldman River. In response to these concerns the following study was designed to evaluate the spring movement of fish in the river in the vicinity of the dam site, plus the extent of spring spawning activity within and above the proposed Full Supply Level (FSL) of the reservoir.

1.1 Objectives

The objectives of this study were:

(1) To monitor the spring movements of fish in the Oldman River within the vicinity of the proposed Oldman River dam site.

(2) To monitor the spring movements of fish through the LNID weir fishway.

(3) To determine the duration and timing of spring spawning activity above and within the areas on the Crowsnest, Castle, and Oldman Rivers planned for flooding.

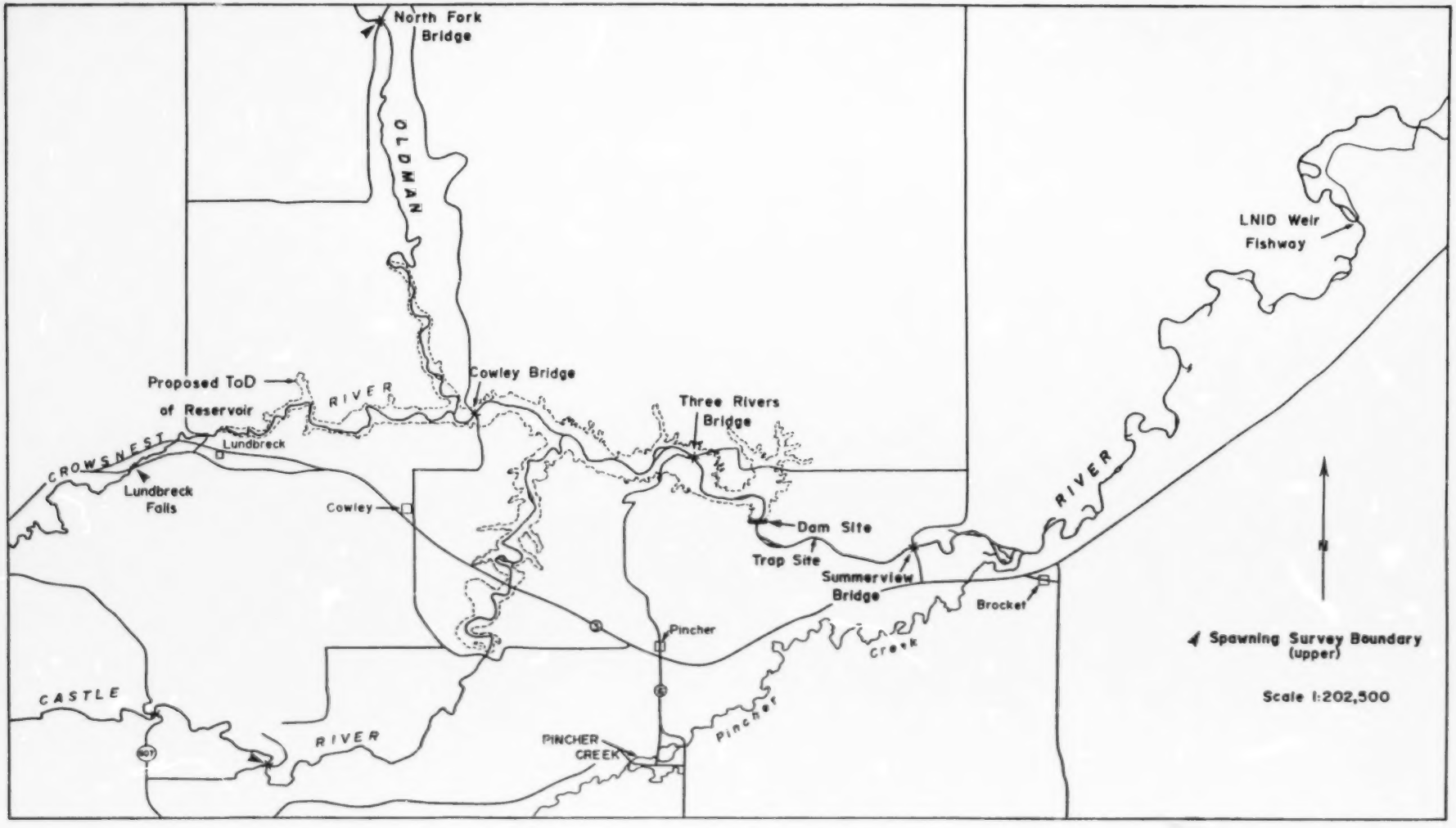

Figure 1. Map of the study area showing extent of the reservoir at top of dam (ToD), river trap site, LNID weir fishway, and spawning survey boundaries.

1.2 Study Area

The Oldman River is located in southwestern Alberta, originates in an alpine lake on the east slopes of the Rocky Mountains, and flows in a generally eastward direction before joining with the Bow River north of the village of Grassy Lake to form the South Saskatchewan River.

Radford (1975) has classified the Oldman River into three regions based on general river characteristics. Region 1 extends from the headwaters downstream to near Brocket, Alberta and is characterized by cold water temperatures, low turbidity, and high gradient. Region 3 extends from near Lethbridge, Alberta downstream to the Bow River confluence and displays warm water temperatures, greater turbidity, and low gradient. Region 2, located between Regions 1 and 3, is classified as a transitional zone with respect to temperature, turbidity, and gradient.

The proposed Oldman River dam site is located approximately 11 km west of the town of Brocket (i.e. within Region 1) while the LNID weir and fishway is located about 17 km northeast of Brocket (i.e. within Region 2) (Figure 1) and represents the lower end of the study area. The upper study area boundaries (Figure 1) are:

i) the North Fork bridge on the Oldman River;

ii) Lundbreck Falls on the Crowsnest River; and

iii) the first bridge crossing downstream of the Highway 507 bridge on the Castle River.

1.3 Background

Corresponding with the three different regions of river characteristics described above are three different fish zones: a cold water species zone, a warm water species zone, and a transitional species zone (Radford 1975). The Oldman River system above Brocket and therefore including the dam site, has been reported to

include the following cold-water game species: mountain whitefish (Prosopium williamsoni), rainbow trout (Salmo gairdneri), bull trout (Salvelinus confluentus), brown trout (Salmo trutta), and cutthroat trout (Salmo clarki).

The Oldman River mainstem from Brocket to Lethbridge, which would include the LNID weir, is a transitional zone between the upstream cold water fish zone and the downstream warm water fish zone. Allen (1985) has listed the following cool water game species inhabiting this zone: lake whitefish (Coregonus clupeaformis), northern pike (Esox lucius), goldeye (Hiodon alosoides), sauger (Stizostedion canadense), and walleye (Stizostedion vitreum). Among the large non-sport species, longnose suckers (Catostomus catostomus), white suckers (Catostomus commersoni), mountain suckers (Catostomus platyrynchus) and burbot (Lota lota) are found in both zones. The shorthead redhorse sucker (Moxostoma macrolepidotum) has been found in the cool-water zone up to about 14 km upstream of the LNID weir (O'Neil et al. 1982).

The primary species of interest in this study were mountain whitefish and rainbow trout which are the predominant game species in the study area. Mountain whitefish are fall spawners, and movements past the dam site would be expected to be in an upstream direction, from downstream overwintering areas to upstream feeding and rearing areas. Rainbow trout, on the other hand, are spring spawners and would be expected to be migrating upstream during the period following ice break-up in order to spawn in suitable areas of possibly all three river systems, i.e., the upper Oldman, Crowsnest, and Castle Rivers.

General migration of fish in the Oldman River system has historically been impeded by the LNID weir at Brocket, Alberta. However, in 1984, a fishway was installed by Alberta Environment during construction of a new headworks system. As a result, large scale spring migrations past this site towards the proposed dam site are now more likely. Species moving through the fishway may include those already noted, especially mountain whitefish which were found to occur in quite large numbers below the weir during the fall of 1984, and to a lesser extent, lake whitefish (IEC Beak 1985b).

The LNID weir is a main headworks system consisting of the weir itself, a fishway, a sluiceway, and the headgates leading to the irrigation canal. The fishway is a standard vertical slot fishway located between the sluicegate and weir. Diversion into the irrigation canal usually begins in April or May and continues until sometime in October when the demand for irrigation water has ended. During this time the sluicegate at the weir is generally closed in order to maintain sufficient head above the weir for desired flow diversion into the irrigation canal. The sluicegate can be opened partially, however, during periods of high flow in order to flush accumulating debris away from the headgates leading to the irrigation canal. Once diversion to the canal has ended, the sluicegate is fully opened and trapped water above the weir is drained in preparation for winter. Operating procedures have not been established that would maintain minimum flows in the fishway.

Means of passage for fish past the LNID weir is dependent on season and flow conditions. During the fall, winter and early spring period when the sluicegate is fully open, fish passage is through the sluiceway only since water levels drop below the base of the fishway exit (IEC BEAK 1985b). When the sluicegate is partially open during high flow conditions, fish probably can move easily downstream through the sluiceway, but upstream passage would be prohibited by high water velocities under the sluicegate. During this time and when the sluicegate is completely closed, both upstream and downstream passage is possible through the fishway, and downstream only passage by a parallel "riparian flow conduit". It is also conceivable that during high flow conditions when the sluicegate is completely or partially in place, that fish migrating downstream could pass over the crest of the weir. Minor upstream and major downstream movements of fish were documented by IEC BEAK (1985b) past the LNID headworks in the fall of 1984. A major objective of this study was to establish whether spring movements were also occurring.

2.0 METHODS

2.1 Movements of fish in vicinity of dam site

a) River Trapping Program

A trapping program was initiated on 10 April 1985 to monitor upstream and downstream migrants in the Oldman River near the proposed dam site. A site was chosen approximately 3 km downstream of the dam site on the basis of its wide and shallow channel configuration and availability of road access to both sides of the river (Figure 1).

Trapping at the dam site was not considered feasible since access was severely limited and channel shape not conducive to successful trapping. It was assumed that fish migrating past the trap site were also likely to continue upstream past the proposed dam site. A pair of traps, tied securely together, were installed along each river bank, originally in about 0.5 m depth, one trap facing upstream and the other downstream within each pair. Each trap was 2.4 m long by 1.2 m wide and high, and was constructed of 5.1 cm x 10.2 cm wooden frames covered by 0.6 cm mesh Vexar nylon netting. The trap funnel was made of 0.6 cm mesh cotton webbing which narrowed to a 14 cm diameter hoop opening.

The fence design was adjusted over the course of the trapping program from 10 April to 27 April 1985, varying with flow conditions. In slower water, such as on the bank side (inside) and for some distance on the river side (outside) of each pair of traps, nylon webbing of generally 1.3 cm mesh size and 1.6 m depth was used as fencing material, and was secured at both the lead and float lines to heavy gauge (1.3 to 2.5 cm diameter) rebar. In faster water, 1.2 m x 1.2 m metal interlocking panels were used as fencing material. Each panel was constructed of angle iron (3.8 cm wide, 0.3 cm thick) frames fitted with expanded wire mesh (1.3 cm, 13 F gauge) screening bolted to the frames. A 15.2 cm overlap in screening on each side of the panel allowed the panels to be bolted together with no gaps between them. As well, angle iron bracing, constructed in a triangular configuration, was extended out behind both sides of each panel. Openings at various points in the frame bottom of each panel allowed further reinforcement with rebar pounded

into the river bottom. The fence portion comprised of interlocking panels was, therefore, very strong and stable. Twenty six of these panels (or about 28 m total length) were assembled at the trap site.

The first attempt at fencing the Oldman River was initiated on April 12, 1985. Panels were extended from a central position in the channel towards both banks along a diagonal line leading between the two pairs of traps. The objective was to block the entire river to migrating fish and to guide them into the appropriate up or downstream traps. Unseasonably warm weather, unfortunately, caused a rapid increase in mountain runoff (Table 1) and by April 15, 1985 it became impossible to maintain the central fence sections or to continue to add new panels, due to very high stream velocities.

During the period of high flows (April 15-21) only very limited sections of the river were fenced (approximately 10%). During this period, the traps were operating with about 8 m of fencing (both panels and nylon webbing) extending downstream and diagonally away from the upstream migrant trap of each pair of traps. Flows receded somewhat during the period from 23 to 25 April, enabling the addition of more panels and nylon webbing so that finally about 65 percent of the river width was covered by downstream-extending fence wings. Fence wings extending up into the current were comprised of only 2 or 3 steel panels due to the greater water pressures involved. Flows began to increase dramatically again on 27 April (Table 1), and by 29 April the existing fence was rendered ineffective due to sections being washed out or excessive amounts of water spilling over top.

b. Electrofishing Program

Since the fish fences could not be maintained during flood conditions, the remaining field effort was directed towards a boat electrofishing program from 29 April to 9 May 1985 in order to capture and tag as many game fish as possible in the vicinity of the proposed dam site. The Oldman River was divided into a series of consecutive riffle-run complexes from Three Rivers Bridge to Summerview Bridge (Figure 1). A three-man crew, equipped with a 5 m long inflatable boat and a 1.5 KVA Smith-Root boat electrofisher, systematically electrofished each riffle-run complex. Electrofishing was generally at 350 V

pulsed DC with an output of about 2 A in shallow water (less than 0.5 m depth) and about 3 A in deeper water. The cathode consisted of a 0.4 m wide strip of fine aluminum screening wrapped around the bottom of the boat at the stern. The anode was made up of a set of flexible and rectractable antennae extending down from a boom attached to the bow of the boat. This system proved very effective in attracting fish of different species and size ranges towards the bow where they could be easily dipped out. Starting at the head of each riffle, the boat was allowed to drift downstream with the current while electrofishing. Two crew members at the bow of the boat dipped out stunned fish and placed them in plastic holding tubs near the front of the boat. Once in the run, two sweeps were made, one along each bank in a downstream direction. Game species of fish were generally processed once sampling of a particular riffle-run complex was complete; however, when fish in the holding tubs began to appear stressed, they were immediately processed and released in an area where they would be unlikely to be recaptured. Game fish were anaesthetized with 2-phenoxyethanol, and general life history information was collected, including species, fork length (mm), weight (g), and where possible, sex and sexual maturity by external characteristics. All game fish larger than about 140 mm fork length were tagged with numbered Alberta Environment Floy anchor tags which offered a $2.00 reward for return. Signs advertising the program were placed in stores, campgrounds and river access points throughout the study area. Individual fin clips were used to mark the general location of smaller game fish captured. Fin clips used were:

1. Cowley Bridge to the dam site - left pectoral;
2. Dam site to river trap site - upper lobe of caudal; and
3. Trap site to Summerview bridge - right pectoral.

All fisheries field data were later transcribed to 80 column computer data sheets in the format set out by Alberta Fish and Wildife for fish tag data, and are presented in Appendix 1.

Each of the riffle-run complexes was sampled twice (on 2 separate visits) during the field program, except for the section from the trap site to Summerview bridge, in which the first two and the last two riffle-run complexes were sampled 3 times and 1 time, respectively.

2.2 Movements of fish through LNID weir fishway

Movements through the fishway were monitored from 16 April, when the sluicegate was closed and water diversion into the LNID irrigation canal began, to 11 May 1985.

The fishway consists of ten pools which are 2.5 m long, 2 m wide and 2.2 m high. The vertical slot between the ponds is approximately 20 cm wide with a sill block on the floor. A detailed description of the fishway design and specifications are given in IEC BEAK (1985b).

An identical trapping system to that used in fall of 1984 (IEC BEAK 1985b) was used to capture all upstream and downstream migrants during the study period. Traps were installed in the 6th (lower) and 7th (upper) resting pools and then moved up to compartments 8 and 9 respectively on 3 May 1985 in order to accommodate rising water levels in the river and fishway (Table 1).

The upstream trap (i.e. the trap designed to capture upstream migrants) consisted of a nylon mesh (1.0 cm stretch) cone attached to a frame constructed of 2 by 2 inch lumber. The trap entrance was braced against the inside baffle and the outside (i.e. southwest) wall of the fishway, and was set approximately 30 cm upstream of the vertical slot, thereby covering the entranceway to the sixth resting pool. The cone exit was 15 cm in diameter and was suspended with heavy gauge wire approximately 50 cm above the floor of the pool and parallel to the outside wall. A screen was inserted across the slot between the sixth and seventh (or eight and ninth) pools to segregate up and downstream migrants.

Downstream movement was recorded by placement of a second cone in the vertical slot area above the seventh (or ninth) pool. The cone itself was of similar construction to the upstream trap. However, it was only framed with 2 by 2 inch lumber on the upstream edge, since water pressure maintained the cone in the correct position. The frame was braced against the upstream walls of the vertical slot and held in place by the current.

Traps in the fishway were checked daily. A blocking screen was placed across the fishway entrance and then flow to the fishway was cutoff by dropping a section of plywood into the "fish screen slot" which was located below the fishway exit. Once the fishway had drained to the water surface elevation of the river at the fishway entrance, the holding pools were entered, examined and all fish removed. The other upstream pools and the accessible downstream pools (the water depth in some pools was over 1.5 m, making inspection difficult) were also examined in case fish were holding in the pools above or below the traps. The traps were then lifted, cleaned and replaced, and flow re-established through the fishway.

Game species of fish captured were processed as in Section 2.1, i.e., measured for forklength (mm) and weight (g) and where possible, their sex and sexual maturity determined by external characteristics. Non-game species of fish were enumerated and released. All game fish larger than about 140 mm forklength were tagged with Alberta Environment Floy anchor tags. Downstream migrants were released immediately below the fishway entrance, and upstream migrants above compartment 10, in quiet water just behind the fishway control gate.

Stage was measured daily in vertical slot 9, located between pools 9 and 8, while the traps were removed from the fishway for cleaning. These data were used to calculate flows through the fishway with the aid of a stage-discharge curve developed during the 1984 fall study (IEC BEAK 1985b) and are presented in Appendix 2.

Electrofishing was conducted below the weir on 11 May 1985 to determine if fish were congregating below the weir rather than moving up into the fishway. A boat mounted electrofishing system, as described in Section 2.1, was employed. Each of the 7 compartments making up the LNID weir were sampled for about 15 minutes. Associated riffle habitat was sampled by drifting and electrofishing down through it. The first compartment was comprised of the sluiceway, and the second compartment included the entrance to the fishway. Captured fish were identified to species, enumerated and then released.

2.3 Assessment of spring spawning activity upstream of dam site

An investigation was undertaken to determine what sections within and immediately upstream of the areas to be inudated by the proposed dam were used by spawning salmonids, in particular, rainbow trout, and to assess the suitability of potential spawning habitat. Two different methods were employed to meet these objectives, the consequence of vastly different flow conditions during the study period. It was originally proposed to begin the spawning surveys during the last two weeks of April. However, the difficulties encountered in setting up and maintaining the trapping operations delayed the surveys. With the subsequent second period of high mountain runoff beginning April 29, 1985, it was necessary to switch from the techniques used April 28 (visual observation) to a boat mounted electrofishing survey.

A boat float survey to count rainbow trout redds and adults and to assess potential spawning habitat was conducted on the Oldman River from Three Rivers bridge downstream to the trap site (Figure 1) on 28 April 1985. Flow in the river was 25.0 m^3/s (Table 1) and visibility was good (about 1.5 m) at this time. A two-man crew drifted downstream in a 3.7 m long inflatable boat; the person at the stern of the boat was responsible for steering the boat as well as visual observations while the second investigator located at the bow of the boat was responsible for visual observation, photographs, and recording information on 1:50,000 topographic maps.

High flows and turbid water conditions following this date precluded carrying out a similar redd count survey and assessment of potential spawning habitat in areas upstream of the Three Rivers bridge. Water visibility was very poor in all study sections (less than 0.5 m) during this period.

Since poor water visibility prevented direct observation of adult trout or redds, it was decided, therefore, to conduct a boat electrofishing program study and to use the count of adult rainbow trout observed as a measure of the suitability of a particular area for spawning rainbow trout. A similar boat electrofishing system was used as in Section 2.1.b. The boat was allowed to drift downstream while electrofishing. For expediency, no fish were tagged, but rather stunned fish were

Table 1. Daily flows in the Oldman River near Brocket and in the LNID irrigation canal during April and May 1985 (WSC; subject to correction)

Date	Oldman R. (m^3/s)	LNID canal (m^3/s)	Date	Oldman R. (m^3/s)	LNID canal (m^3/s)
1 April	8.20 I	0	1 May	57.4	20.6
2 April	10.6	0	2 May	63.3	20.5
3 April	13.2	0	3 May	84.6	20.2
4 April	11.8	0	4 May	108	19.8
5 April	10.4	0	5 May	91.3	20.7
6 April	10.2	0	6 May	74.6	20.1
7 April	8.9	0	7 May	66.2	20.0
8 April	8.6	0	8 May	63.5	20.4
9 April	9.9	0	9 May	62.7	20.1
10 April	13.1	0	10 May	62.1	18.6
11 April	17.9	0	11 May	60.0	17.4
12 April	22.3	0	12 May	54.4	17.3
13 April	29.0	0	13 May	49.9	15.5
14 April	46.4	0	14 May	49.8	14.3
15 April	56.8	0	15 May	51.3	14.3
16 April	47.0	3.6	16 May	56.2	14.3
17 April	44.8	13.9	17 May	67.3	12.4
18 April	44.0	18.9	18 May	80.9	11.1
19 April	40.2	19.7	19 May	101	10.9
20 April	36.0	20.1	20 May	116	11.0
21 April	29.6	19.9	21 May	123	10.9
22 April	26.5	20.6	22 May	127	11.2
23 April	23.5	20.5	23 May	130	13.4
24 April	21.7	20.4	24 May	131	16.3
25 April	20.2	20.8	25 May	140	18.4
26 April	19.1	20.5	26 May	142	18.4
27 April	17.2	20.0	27 May	118	17.2
28 April	25.0	19.8	28 May	102	15.3
29 April	58.3	19.6	29 May	95.4	14.5
30 April	60.1	20.4	30 May	99.2 E	13.5 E
			31 May	100 E	13.5 E

I ice conditions
E estimated

dipped out and examined to allow positive species identification, enumerated, and then immediately released. The four study sections and dates sampled were:

May 4 - Oldman River, North Fork Bridge to Cowley Bridge

May 5 - Crowsnest River

May 6 - Castle River

May 7 - Oldman River, Cowley Bridge to Three Rivers Bridge

At the request of Alberta Environment certain portions of the study sections were not sampled (Figures 2 and 3).

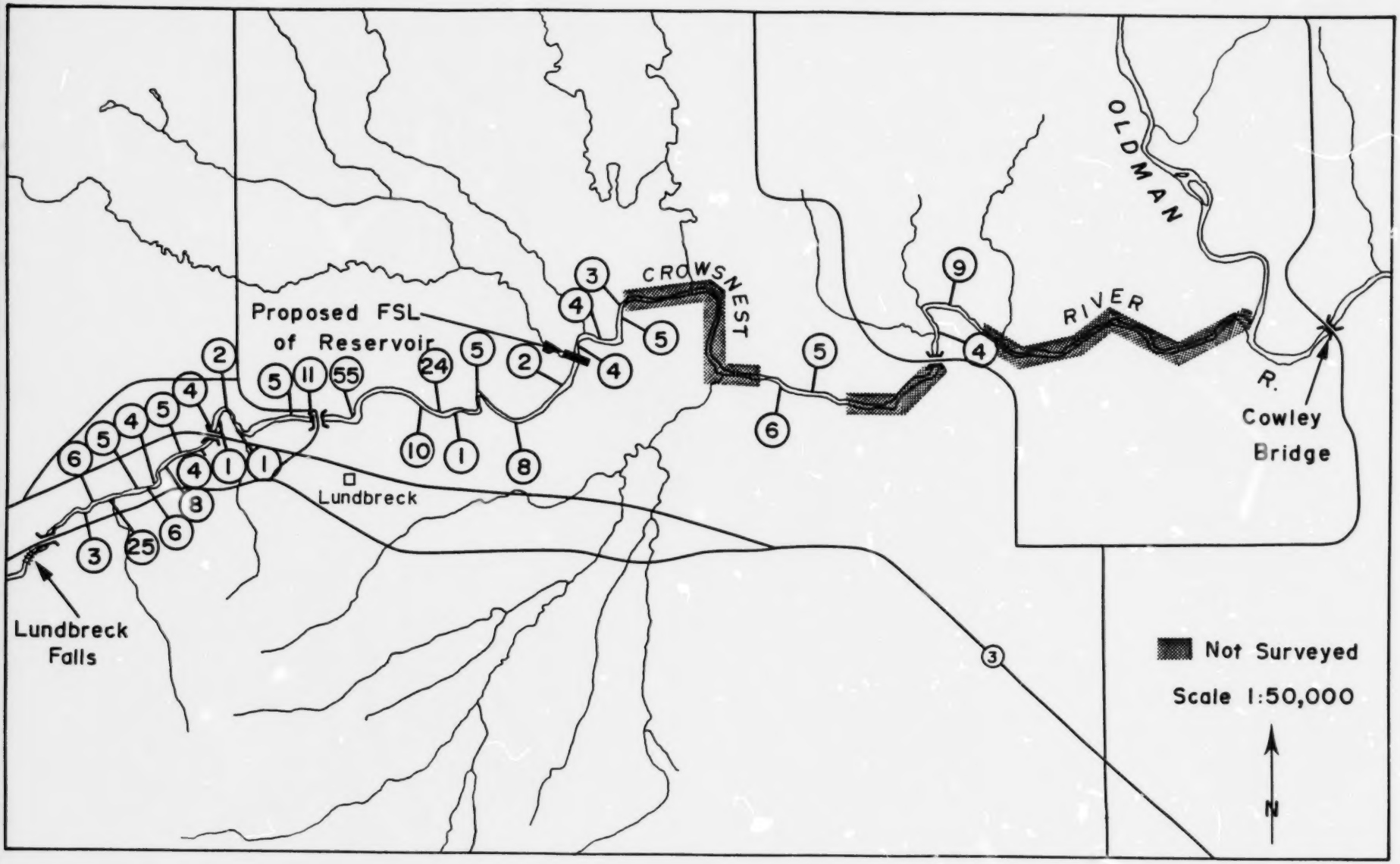

Figure 2. Locations and numbers of observed adult rainbow trout during the spawning survey on the Crowsnest River.

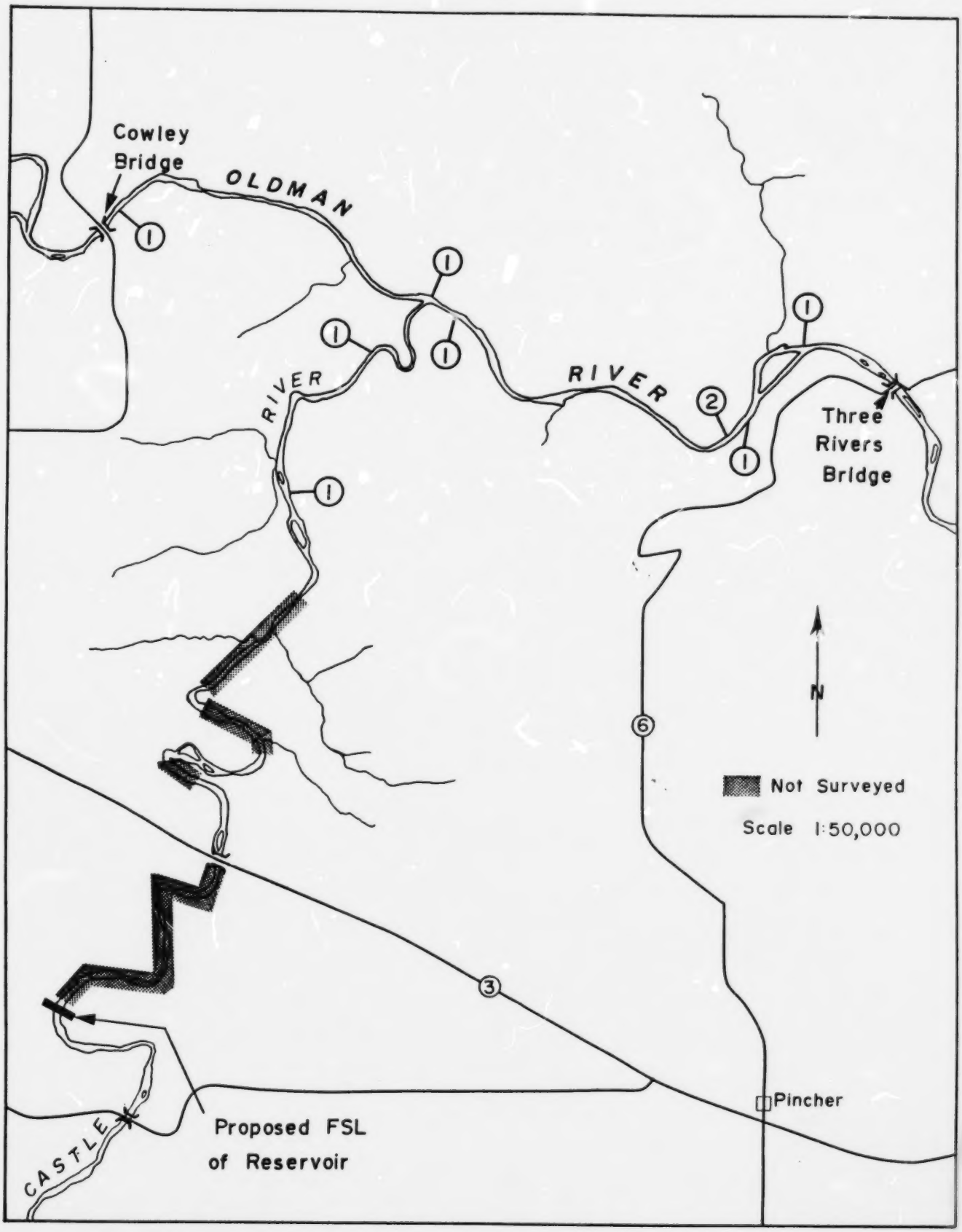

Figure 3. Locations and numbers of observed adult rainbow trout during spawning surveys on the Castle and Oldman Rivers.

3.0 RESULTS

3.1 Species Composition and Relative Abundance

The major fish species captured during the spring field program are listed in Table 2. No attempt was made in this study to enumerate the forage species (e.g. minnows, sculpins, trout perch) captured. Sucker species were enumerated at the trap site and LNID weir fishway, but not during electrofishing operations.

A total of 1,399 game fish were captured from 15 April to 11 May 1985 as part of the study investigating movements of fish at the LNID weir and in the vicinity of the proposed Oldman River dam site (Table 3). Of these, 887 fish were tagged with an orange Alberta Environment Floy anchor tag and 163 were fin-clipped.

Mountain whitefish were the predominant game species (non-game fish were not enumerated) in the vicinity of the proposed dam site, and the predominant fish species (including non-game species) at the LNID weir fishway, comprising 93.0 percent and 84.6 percent, respectively, of the total catch. Rainbow trout were the next most common game species, comprising 6.5 percent of the game species catch in the vicinity of the dam site, and 2.8 percent of the game and non-game species catch at the LNID weir fishway. Bull trout and brown trout were not found at the LNID weir fishway, and were observed only rarely near the dam site (0.4 percent and 0.2 percent, respectively, of the total game species catch).

An additional 2695 game fish were counted, but not sampled, during electrofishing operations from 4 to 7 May 1985 as part of the spring spawning survey (Section 3.4). Mountain whitefish were again the predominant game species (90.4%), followed by rainbow trout (9.1%), lake whitefish (0.3%), bull trout (0.1%) and brown trout (0.1%).

The occurrence of lake whitefish in the Crowsnest River is significant in that it is the furthest upstream occurrence reported for lake whitefish in the Oldman River system and the first observation reported for the Crowsnest River. A single lake whitefish was found about 7 km above the LNID weir by O'Neil et al. (1982), and a total of 129 lake whitefish were captured during a 1984 fall study at the LNID

Table 2. Scientific names, common names and letter codes for fish species observed in the Oldman River study area during April and May, 1985.

Scientific Name	Common Name	Species Code
Salmonidae		
Coregoninae		
Prosopium williamsoni	mountain whitefish	MTWT
Coregonus clupeaformis	Lake whitefish	LKWT
Salmoninae		
Salmo gairdneri	rainbow trout	RBTR
Salmo trutta	brown trout	BRTR
Salvelinus confluentus	bull trout	BULL
Gadidae		
Lota lota	burbot	BURB
Catostomidae		
Catostomus catostomus	longnose sucker	LNSK
Catostomus commersoni	white sucker	WTSK

Table 3. Catch summary of game fish species in the Oldman River during April and May 1985 (N = number captured, T = number tagged, F = number fin-clipped).

	MTWT						RBTR			BULL			BRTR		
	>1+ age			1+ age											
	N	T	F	N	T	F	N	T	F	N	T	F	N	T	F
Electrofishing[1]	871	565	128	102	0	28	67	58	7	4	4	0	2	1	0
Traps															
Upstream migrants	5	1	0	-	-	-	1	0	0	-	-	-	-	-	-
Downstream migrants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LNID Fishway															
Upstream migrants	328	243	0	-	-	-	7	6	0	-	-	-	-	-	-
Downstream migrants	8	6	0	-	-	-	4	3	0	-	-	-	-	-	-
Totals	1212	815	128	102	0	28	79	67	7	4	4	0	2	1	0

[1] Electrofishing from Pincher Creek bridge to Summerview bridge (does not include spawning survey data).

weir (IEC BEAK 1985b).

No cutthroat trout (Salmo clarki) were observed during this study, although Radford (1975) reported their presence in the Crowsnest and Castle Rivers. Burbot were not considered a game species in this study and were found only infrequently. Three individuals were observed during electrofishing operations on the Oldman River between the Three Rivers and Summerview bridge and 2 more were captured as upstream migrants in the LNID weir fishway. Longnose suckers were the most common sucker species at the LNID weir fishway (total 35), but 13 white suckers were also captured.

It is noteworthy that many of the fish species listed by Allen (1985) as inhabiting the cool water zone which encompasses the LNID weir were not captured in the fishway, including lake whitefish, northern pike, goldeye, sauger, walleye, mountain suckers, and shorthead redhorse suckers.

3.2 Movements of fish in the vicinity of the Dam Site

Increasing flows during the study period (Table 1) prevented implementation of an effective fish trapping program. During the period of operation from 15 to 29 April 1985, only 5 mountain whitefish, 1 rainbow trout, 4 longnose suckers and 2 white suckers were captured. The mountain whitefish, rainbow trout and one individual white sucker were upstream migrants while the remaining suckers were downstream migrants.

Fortunately, high flow conditions did not preclude carrying out boat electrofishing operations from 29 April to 9 May 1985 in the vicinity of the proposed dam site, i.e. from Cowley bridge downstream to Summerview bridge. A total of 628 game fish were tagged with orange Alberta Environment floy anchor tags and 163 fish were fin clipped. Numbers of each game species captured, tagged or fin clipped are in Table 3. Smaller mountain whitefish (less than 120 mm fork length) were designated as 1+ age. This distinction was based on length frequencies observed in the field and in previous studies on the Highwood River (IEC BEAK 1984, 1985a), Oldman River (IEC BEAK 1985b), and Sheep River (Thompson 1974).

Catch per unit effort (CPUE) values for each species and river sub-section are given in Table 4. There was no clear trend in species abundance longitudinally through the river, although the section from the proposed dam site to the trap site (Figure 1) seemed somewhat more productive for mountain whitefish than were the other two sections. There is other evidence that the section of river below the dam site may be relatively important rainbow trout habitat. During a spring fish survey (14 to 19 May 1982) of 52 km of the Oldman River downstream from the Cowley bridge, O'Neil et al. (1982) found the majority of rainbow trout (i.e., 18 of 25 fish) in a 5 km section of river from near the dam site downstream to the Summerview bridge. The authors cautioned, however, that the absence of rainbow trout in their sample from upstream from this area was likely due to limited sampling effort, and so this reach may also include important rainbow trout habitat.

Only 2 of the 58 tagged rainbow trout were recaptured (Table 5). No fin-clipped trout were recovered. Movement by the two recaptured trout was not extensive; one individual had moved upstream to the adjacent riffle/run (about 0.9 km) over a 7 day period, and the other individual was recaptured after a 4 day period in the riffle/run it was originally found in. The reproductive condition of these trout is unknown since they were released alive rather than sacrificed for examination of gonadal development. The size of the two fish (Table 5), however, suggests they could be sexually mature.

Sixteen tagged and one fin-clipped (left pectoral) mountain whitefish were recaptured. There was no clear trend in direction of movement by tagged whitefish; of the 16 recaptures, 6 were moving upstream, 5 downstream, and 5 were recaptured in the same riffle/run they were originally found in. Distances covered during capture - recapture periods were not great. The greatest distance moved by a upstream migrant was 2.0 km (in 8 days) and by a downstream migrant 0.85 km (in 1 and 6 days). Rates of movement were somewhat greater for downstream than upstream migrants; mean rates were 460 m/d and 140 m/d, respectively. Distance and rate of movement values may be conservative, however, since activity of individual tagged fish between tagging and recapture is unknown. Furthermore, it is not known what proportion of tagged fish left the area of electrofishing altogether, and thus would not be represented in the recapture statistics.

Table 4. Number of salmonids captured during electrofishing operations on the Oldman River from Three Rivers bridge to Summerview bridge from 29 April to 11 May 1985. Numbers in parenthesis are CPUE values adjusted for number of site visits and length of each riffle-run complex (i.e., number of fish/visit/km).

A. Three Rivers bridge to Dam Site (Pb)

Riffle-run complex	Length (km)	MTWT >1+ age		MTWT 1+ age		RBTR		BRTR		BULL	
Pb 1	0.5	23	(23.0)	6	(6.0)	-	-	-	-	-	-
Pb 2	0.4	38	(47.5)	1	(1.2)	3	(7.5)	-	-	-	-
Pb 3	0.7	22	(15.7)	1	(0.7)	10	(7.1)	-	-	-	-
Pb 4	1.1	43	(19.5)	5	(2.3)	5	(2.3)	-	-	-	-
Pb 5	1.0	87	(43.5)	15	(7.5)	2	(1.0	-	-	1	(0.5)
Pb 6	0.7	71	(50.7)	1	(0.7)	7	(5.0)	-	-	-	-
Total	4.4	284	(32.3)	29	(3.3)	27	(3.1)	-	-	1	(0.1)

B. Dam Site to Trap Site (Da)

Riffle-run complex	Length (km)	MTWT >1+ age		MTWT 1+ age		RBTR		BRTR		BULL	
Da 1	0.5	47	(47.0)	2	(2.0)	4	(4.0)	-	-	-	-
Da 2	0.8	59	(36.9)	1	(0.6)	-	-	-	-	-	-
Da 3	0.7	65	(46.4)	32	(22.9)	4	(2.9)	-	-	1	(0.7)
Da 4	0.5	45	(45.0)	4	(4.0)	5	(5.0)	1	(1)	-	-
Da 5	0.4	38	(47.5)	2	(2.5)	6	(7.5)	-	-	-	-
Da 6	0.4	74	(92.5)	3	(3.8)	6	(7.5)	-	-	1	(1.25)
Total	3.3	328	(49.7)	44	(6.7)	25	(3.8)	1	(0.2)	2	(0.3)

C. Trap Site to Summerview Bridge (Tr)

Riffle-run complex	Length (km)	MTWT >1+ age		MTWT 1+ age		RBTR		BRTR		BULL	
Tr 1	0.6	53	(29.5)	10	(5.5)	5	(2.8)	-	-	1	(0.5)
Tr 2	1.2	150	(41.7)	19	(5.2)	4	(1.1)	1	(0.2)	-	-
Tr 3	0.8	28	(35.0)	-	-	3	(3.8)	-	-	-	-
Tr 4	0.5	28	(56.0)	-	-	3	(6.0)	-	-	-	-
Total	3.1	259	(38.7)	29	(4.3)	15	(2.2)	1	(0.1)	1	(0.1)
Grand Total	10.8	871	(39.4)	102	(4.6)	67	(3.0)	2	(0.1)	4	(0.2)

Table 5. Fork lengths, weights, and movements of recaptured tagged fish during electrofishing operations on the Oldman River, 29 April to 11 May 1985.

Species	FL (mm)	Wt. (g)	Recapt. Date	Recapt. Loc.	Date Marked	Marking Loc.	Tag Number (prefix BOO)	Distance Moved (km)	Direction (Upstr. or Downstr.)	Number Days
RBTR	220	120	3 May	TR 1	29 Apr	Tr 1	5244	-	-	4
RBTR	253	180	7 May	Pb 3	30 Apr	Pb 4	5890	0.9	U/S	7
MTWT	371	580	2 May	Da 3	1 May	Da 2	5871	0.75	D/S	1
MTWT	271	210	3 May	Tr 2	29 Apr	Tr 2	5237	-	-	4
MTWT	275	240	7 May	Pb 2	30 Apr	Pb 3	5918	0.55	U/S	7
MTWT	275	230	7 May	Pb 3	30 Apr	Pb 4	5907	0.9	U/S	7
MTWT	284	250	7 May	Pb 3	30 Apr	Pb 4	5908	0.9	U/S	7
MTWT	230	160	7 May	Pb 4	30 Apr	Pb 4	5895	-	-	7
MTWT	310	340	7 May	Pb 4	30 Apr	Pb 5	5881	1.05	U/S	7
MTWT	298	250	7 May	Pb 5	1 May	Pb 6	5768	0.85	D/S	6
MTWT	184	100	8 May	Pb 6	7 May	Pb 5	5178	0.85	D/S	1
MTWT	253	170	8 May	Da 1	1 May	Da 2	5861	0.65	U/S	7
MTWT	214	110	8 May	Da 1	1 May	Da 1	5746	-	-	7
MTWT	291	270	8 May	Da 1	30 Apr	Pb 4	5905	2.0	U/S	8
MTWT	318	460	9 May	Tr 1	2 May	Da 6	5585	0.5	D/S	7
MTWT	320	340	9 May	Tr 1	3 May	Tr 1	5713	-	-	6
MTWT	200	110	9 May	Tr 1	8 May	Da 6	5444	0.5	D/S	1
MTWT	256	190	9 May	Tr 2	3 May	Tr 2	5636	-	-	6

3.3 Movements of fish through LNID weir fishway

Movements of fish through the LNID weir fishway were monitored from 16 April, following the closing of the sluiceway, to 11 May 1985.

The fishway appeared to be effective in allowing passage of fish past the weir during the times the sluicegate was completely closed. As part of the operating procedure of the LNID headworks system, the sluicegate was partially opened during periods of high flow in order to flush accumulating debris away from the headgates leading to the irrigation canal. During the 17 days that the fishway was monitored the sluicegate was partially open for 8 days or 32 percent of the time, yet only 3.3 percent of the total catch was obtained during this period. The reduced numbers of fish using the fishway during this time is probably related to the greater flows associated with the sluiceway than with the fishway. Downstream fish migrants attracted to the sluiceway flows would probably be swept under the sluicegate by the high velocity waters. Upstream migrants as well would be attracted by the greater flows at the sluiceway than at the fishway entrance, but would be unable to move upstream under the sluicegate due to prohibitively high water velocities. Upstream migration would be largely eliminated, therefore, during the period the sluicegate was partially open (i.e. 0.2 m to 0.8 m). It is notewothy that when the sluicegate is completely open, however, water velocities in the sluiceway are not considered prohibitive to upstream fish migration (IEC BEAK 1985b).

Mountain whitefish were the predominant species moving through the fishway; of a total of 397 fish captured, 336 or 84.6 percent were mountain whitefish (Table 6). Almost all (97.6 percent) of these whitefish were upstream migrants.

Rainbow trout were not caught in large numbers and constituted only 2.8 percent of the total catch. Seven of the rainbow trout were upstream migrants while 4 were downstream migrants. There was no significant difference in forklength ($t = 1.78$, $p < 0.5$), but the downstream migrants tended to be smaller then the upstream migrants (means 208.8 mm and 312.9 mm forklength for downstream and upstream migrants, respectively).

Table 6. Catch summary of upstream and downstream migrants at the LNID fishway, spring 1985.

Date	Water Temp (min)	Water Temp (max)	Upstream Migrants MTWT	RBTR	LNSK	WTSK	BURB	Totals	Downstream Migrants MTWT	RBTR	LNSK	WTSK	Totals	Sluicegate Height (m)
April/85														
17	6°	7°	1	-	-	-	1	2	-	-	-	1	1	0.00Closed
18	6°	10°	2	-	2	-	1	5	1	-	-	-	1	0.00
19	6°	7°	-	-	-	-	-	0	1	1	3	2	7	0.00
20	4°	6°	-	-	-	-	-	0	-	-	-	1	1	0.00
21	2°	5°	-	-	-	-	-	0	-	-	-	-	0	0.00
22	3°	10°	-	-	-	-	-	0	-	-	-	-	0	0.00
23	-	-	-	-	1	-	-	1	2	-	-	-	2	0.00
24	4°	10°	28	2	-	-	-	30	-	-	-	-	0	0.00
25	6°	7°	34	-	-	2	-	36	-	1	-	-	1	0.00
26	4°	7°	-	2	-	1	-	3	-	-	-	-	0	0.00
27	5°	8°	-	2	-	-	-	2	-	-	1	-	1	0.00
28	5°	10°	49	1	6	1	-	57	-	2	-	-	2	0.00
29	-	-[a]	4	-	7	4	-	15	1	-	1	1	3	0.20(Open)
30	-	-	-	-	-	-	-	0	-	-	-	-	0	0.20
May/85														
1	-	-	-	-	-	-	-	0	-	-	-	-	0	0.40
2	8°	12°	-	-	-	-	-	0	-	-	-	-	0	0.65
3	8° b		-	-	4	-	-	4	-	-	8	-	8	0.55
4	8°		-	-	-	-	-	0	-	-	-	-	0	0.78
5	5°		-	-	-	-	-	0	-	-	-	-	0	0.70
6	6°		-	-	-	-	-	0	-	-	-	-	0	0.50
7	7°		-	-	1	-	-	1	-	-	-	-	0	0.00Closed
8	11°		1	-	1	-	-	2	-	-	-	-	0	0.00
9	10°		112	-	-	-	-	112	-	-	-	-	0	0.00
10	-		88	-	-	-	-	88	1	-	-	-	1	0.00
11	10°		9	-	-	-	-	9	2	-	-	-	2	0.00
Totals			328	7	22	8	2	367	8	4	13	5	30	

[a] high flows make thermometer inaccessible
[b] thermometer broken

Longnose suckers were the most common coarse fish species caught in the fishway, comprising 8.8 percent of the total catch, followed by white suckers (3.3 percent), and burbot (0.5 percent). The main direction of travel among the coarse fish species was upstream (62.8 percent, 61.5 percent, and 100 percent for longnose suckers, white suckers, and burbot, respectively). Some of the longnose suckers appeared ready to spawn, i.e., readily expulsed sexual products during handling.

If a major upstream migration by rainbow trout occurred, it likely took place before the sluicegate was closed on 16 April 1985. Boat electrofishing below the weir on 11 May 1985 failed to produce any evidence of rainbow trout congregating below the weir, although relatively large numbers of mountain whitefish were found there (Table 7). Mountain whitefish are known to undergo extensive seasonal migrations; presumably upstream migrations are from downstream overwintering areas to traditional upstream spring and summer feeding and rearing areas (e.g. Thompson 1974). It is unclear if mountain whitefish were congregating in pools below the weir because they are more heavily attracted to flows over the weir rather than the fishway and thus are not attracted to the fishway entrance, or if these pools provide suitable feeding habitat and so induce the mountain whitefish not to seek upstream passage past the weir.

3.4 Assessment of spring spawning activity upstream of the dam site

A boat float survey to count rainbow trout redds and adults and assess potential spawning habitat was conducted on the Oldman River from Three Rivers bridge downstream to the trap site on 28 April 1985. Flow in the river was 25.0 m^3/s (WSC near Brocket) and water visibility was rated as good (about 1.5 m). No redds or adult rainbow trout were observed. Substrate was assessed as being generally too coarse for rainbow trout spawning; cobble and boulder was the predominant particle size, often with a large deposit of fines in slower areas. There did appear, however, to be an abundance of deep potential holding or overwintering pools for large salmonids throughout the section examined.

Table 7. Numbers of mountain whitefish observed while electrofishing immediately below LNID weir on 11 May 1985

Weir Compartment	Number Whitefish
1 [a]	0
2 [b]	12
3	62
4	147
5	40
6	65
7	16
Total	342

[a] Sluiceway

[b] Includes fishway entrance

High flows (Table 1) and turbid water (less than 0.5 m visibility) conditions during the period 4 to 7 May 1985 precluded carrying out a similar redd-count survey and assessment of potential spawning habitat in areas upstream of the Three Rivers bridge. It was decided, therefore, to conduct a boat electrofishing program in the Crowsnest, Castle and Oldman River (upstream of Three Rivers bridge) and to use the count of adult rainbow trout observed as a measure of the suitability of a particular area for spawning rainbow trout.

A total of 4 river segements were surveyed for adult rainbow trout between May 4-7, 1985 using electrofishing. These were in chronological order, the Oldman River from North Fork Bridge to the Cowley Bridge (i.e. primarily upstream of the confluence of the Crowsnest and Castle Rivers), the lower Crowsnest River to the confluence with the Oldman River, the lower Castle River to the confluence with the Oldman River, and the Oldman River from the Cowley Bridge to the Three River Bridge (Figure 1). Not all sections were available for sampling, however, due to access restrictions requested by Alberta Environment. In the Oldman River above the Cowley Bridge, 13 km of the 19 km section (68%) was sampled. All of the 9 km section (100%) of the Oldman River from the Cowley Bridge to the Three Rivers Bridge was sampled. In the Crowsnest River 9 km of the 15 km section (60%) was sampled (Figure 2), while in the Castle River 17.5 km of the 25.5 km river section (69%) was sampled (Figure 3).

Rainbow trout were observed in significant numbers only in the Crowsnest River (Table 8). Within the 9 km surveyed, 235 rainbow trout were enumerated. In contrast, only 7 rainbow trout were counted in the 9 km of the mid - Oldman River (Cowley bridge to Three Rivers bridge) examined, 2 rainbow trout in 17.5 km of the Castle River, and no rainbow trout in the 13 km of the Oldman River surveyed upstream of the Cowley bridge to the North Fork bridge. The significantly greater densities of rainbow trout and mountain whitefish in the Crowsnest River compared to the Castle River is probably related to differences in general salmonid habitat quality; however, Lundbreck Falls located on the Crowsnest River is a barrier to upstream migration and therefore may result in increased downstream fish densities. Locations of enumerated rainbow trout during the spawning survey are given in Figures 2 and 3.

Table 8. Number of game fish observed during spring spawning survey, 4 to 7 May 1985.

Section	Length Surveyed (km)	RBTR	MTWT	LKWT	BRTR	BULL
Upper Oldman R.[1]	13	-	24	-	-	1
Mid Oldman R.[2]	9	7	796	-	-	1
Crowsnest R.	9	235	1507	7	3	1
Castle R.	17.5	2	110	-	-	1
Total	48.5	244	2437	7	3	4

1 North Fork bridge to Cowley Bridge

2 Cowley Bridge to Three Rivers Bridge

Five of the seven rainbow trout sacrificed and examined for reproductive condition during the period 2 to 9 May 1985 were spent (Table 9). This suggests the peak in spawning activity may have occurred somewhat earlier. Mean air temperature for the month of April was 2.5°C higher than normal in the Lethbridge area (pers. comm. Environment Canada) which may have initiated earlier than normal spawning activity in the Oldman system. Spawning activity in the Highwood River system of southern Alberta was found to occur mainly between early and mid May in 1984 (IEC BEAK 1985a).

Table 9. Reproductive condition of sacrificed rainbow trout in the Oldman River system during May 1985.

Date	Location	FL (mm)	Wt. (g)	Sex	Maturity
2 May	Oldman R. (Da 5)	295	290	M	Immature
5 May	Crowsnest R.	384	660	F	Ripe
5 May	Crowsnest R.	308	440	F	Spent
5 May	Crowsnest R.	-	-	M	Spent
6 May	Oldman R.[1]	508	1310	F	Spent
6 May	Oldman R.[1]	496	1220	F	Spent
9 May	Oldman R. (Tr 3)	459	980	F	Spent

[1] Cowley Bridge to Three Rivers Bridge

4.0 DISCUSSION

The first objective of the 1985 program was to determine the rate and extent of spring migrations past the proposed Oldman River Dam site. The technique developed to carry out this assessment (i.e. expanded wire mesh fences and fish traps) proved to be ineffective. This was due to several factors. First, the fence materials were quite heavy and difficult to work with. Rapidly rising water levels while the fence was being put into place made it initially impossible to establish the fence. Once in place during lower flows, the fence materials were reasonably effective. However, by the time the fence had been established on the second attempt, the major spring runoff had begun (108 m^3/s on May 4) and it is unlikely that any fence design could cope with those flows.

Should a fencing effort be attempted in 1986, a number of modifications to this year's program are recommended. First, an aluminum conduit fence, such as the one Alberta Environment had constructed in 1984, should be used. Although such a fence is much more expensive, the flows in the Oldman River during even low spring flow conditions (e.g. 25 m^3/s) are simply too great to be effectively fished with the heavy awkward materials used in this study. The fence design used was also not as able to react to higher flows or as readily established under rising water conditions as is the aluminum conduit fence. Second, the operation should begin as soon as possible following ice-out in the river. In 1985, effective trapping could have begin in late March, but was delayed until mid April. Data collected at the LNID weir indicated that if there was a significant spring movement of rainbow trout past the weir, it began well prior to April 16. It is very likely that trapping operations in the river, even if they had not been delayed by the increasing flows of April 11-15 would not have been sufficiently early to monitor upstream movements. Electrofishing operations in late April indicated relatively even numbers of rainbow trout remaining in the stream reaches above and below the dam site. Establishing the trapping fence immediately after ice-out will also permit crews to install traps and fences under the lowest water conditions. Trying to install these materials under the rapidly rising water conditions encountered in this study proved to be frustrating and time consuming (at least two full days were spent retrieving materials lost during the first fencing attempt).

Some tentative conclusions can be drawn from the available data on likely movements of fish past the dam site. First, as noted earlier, if there was a major spring movement of rainbow trout past the LNID weir, this movement must have occurred prior to April 16. It seems very unlikely, however, that the rainbow trout populations in the Oldman River traditionally overwinter below the LNID weir. Prior to 1984, the weir effectively blocked most spring and summer upstream movement. Water diversion at the weir also likely greatly degraded the quality of habitat for trout below the weir. For example, in 1984, summer flows were on occasion reduced to 1-2 m^3/s. In the absence of any significant flow input into the Oldman River above the confluence with the Belly River, it seems unlikely that rainbow trout would normally migrate downstream past the weir over the spring and summer to feed in the Oldman stream reaches below the weir. There was also no evidence in the 1984 study by IEC BEAK (1985b) of a major fall downstream migration by trout, although a number of trout were clearly moving downstream with the much larger whitefish populations.

If no major movements by trout occur past the weir in the spring, then any upstream movement of trout would occur from the river sections between the weir and the dam site. However, channel characteristics change quite substantially in the stream reaches between the Summerview Bridge and the LNID weir. Between the Three Rivers Bridge and the Summerview Bridge, the valley is more deeply incised, river sinuosity is reduced and the stream gradient is approximately 0.4%. Below the Summerview Bridge, the river valley is wide, the channel sinuous and braided, gravel bar formation is common, and the channel gradient is approximately 0.1%. As a result, overwintering habitat in this lower stream section is likely of a lower quality than that found in the upper stream sections. Although unconfirmed, it is expected that overwintering by both trout and whitefish is more likely in the river sections upstream of the Summerview Bridge; however, at least some overwintering undoubtedly also occurs in the river sections below the bridge.

Unlike for rainbow trout, there was good evidence that a steady spring movement of mountain whitefish upstream past the LNID weir occurs. Given the size of the downstream fall movements observed in 1984, this is not surprising. These upstream spring and summer movements are primarily for feeding purposes and

are well documented in the Sheep and Highwood River systems (Thompson 1974, IEC BEAK 1984). The available data for the 16 recaptures within the vicinity of the dam suggest that movements, as would be expected, are not rapid, and not exclusively in an upstream direction. Unless an unexpectedly large movement of mountain whitefish occurred in April, the widespread distribution of the fish in the Oldman and Crowsnest Rivers in May indicates that considerable overwintering by mountain whitefish above the dam site may also occur. The data collected at the LNID weir indicate that the fishway does effectively allow the passage of fish upstream past the weir.

While it was not possible in this study to document exact redd locations, the data do provide an excellent indication of the relative value of the Oldman River above and below the Three Rivers confluence, and the lower Castle and lower Crowsnest Rivers to spawning rainbow trout populations. Except for the Crowsnest River, the remaining river sections all contained relatively small numbers of adult rainbow trout. While it is possible that adult trout migrated upstream into the Castle and Oldman Rivers beyond the study area, it appears that impacts of reservoir formation on trout spawning habitat (assuming that relative density of fish in each stream section corresponds to its value for spawning) will be, in order of importance:

1) Lower Crowsnest River
2) Lower Oldman River (Cowley Bridge to dam site)
3) Lower Castle River
4) Upper Oldman River (above the Cowley Bridge)

Impacts on the lower Crowsnest River are likely to be of particular significance. Seventeen percent of the trout captured in the Crowsnest River were found in the sections below the reservoir FSL. Since it was not possible to sample much of this area, it is likely that the sampling program has greatly underestimated the density of rainbow trout in this portion of the stream. From the data, it would also appear likely that at least some spawning habitat in the Oldman River below the confluence of the Crowsnest River will also be lost.

Loss of feeding and rearing habitat for mountain whitefish, at least during the

spring months, appears to roughly match the data for rainbow trout. Both the lower Crowsnest and the Oldman river between the Cowley Bridge and the dam site contained very large populations of both adult and juvenile whitefish. Flooding of these areas will likely result in a complete loss of feeding and rearing habitat for this species.

In conclusion, the study was unable to confirm or reject the existence of a major spring migration of rainbow trout past the proposed dam site. The Oldman River system differs, however, from most river systems in that summer stream flow is greatly reduced in the downstream reaches (due to the LNID diversion). It would seem unlikely that trout undergo any successful major downstream migrations in the system, particularly since these lower reaches are within the cool water - warm water transition zone and below the traditional blockage point of the LNID weir. It does appear that the stream reaches above the dam site likely meet all the life history requirements of local trout populations, and it is quite possible that at least a portion of the trout populations are year-round residents. The study also found that the LNID fishway is effective in passing upstream migrants, but that a number of operational and physical changes are required to maximize fish passage. Finally, the study indicated that the lower Crowsnest River was clearly more important to spawning rainbow trout than the other stream sections. Loss of this habitat, plus inundation of the Oldman River below Cowley Bridge are likely to have a significant impact on both rainbow trout and mountain whitefish populations.

5.0 SUMMARY AND CONCLUSIONS

5.1 Species composition and relative abundance

1. A total of 4094 game fish were captured during the period 15 April to 11 May 1985. Mountain whitefish were the predominant species comprising 91.6 percent of the total game fish catch. Rainbow trout made up most of the remaining portion (7.9 percent) of the total game fish captured, followed by, in descending order of occurrence, bull trout, lake whitefish, and brown trout. Longnose suckers were the predominant non-game species encountered at the LNID weir fishway, followed by white suckers, and burbot.

2. The first known observations of lake whitefish in the Crowsnest River were recorded, thus significantly extending their upstream range in the Oldman River system. Lake whitefish were not captured, however, in the Oldman River mainstem or at the LNID weir fishway, suggesting that either a resident population exists in the upper Oldman system, or the lake whitefish moved upstream past the LNID weir before 16 April.

5.2 Movements of fish in the vicinity of dam site

1. The fish trapping program near the proposed Oldman River dam site was rendered ineffective by flood conditions during the period of study. As an alternative means of monitoring fish movements, an electrofishing/tagging program was undertaken from Three Rivers bridge to Summerview bridge. A total of 628 game fish were tagged and 163 additional fish were fin-clipped during sampling of discrete riffle-run complexes from 29 April to 9 May 1985.

2. Only 2 of 58 tagged rainbow trout were recaptured. Movement by these 2 individuals was not extensive; one was found in the same location after 4 days, and the other had moved upstream about 0.9 km over 7 days.

3. Sixteen of 565 tagged and 1 of 156 fin-clipped mountain whitefish were recaptured. There was no clear trend in general direction of movement, and distances travelled were not great. The greatest distance moved was 2.0 km in 8 days by an upstream migrant. These values may be conservative, however, since it is not known what proportion of tagged mountain whitefish or rainbow trout left the area of electrofishing altogether, and thus would not be represented in the recapture statistics.

5.3 Movements of fish through LNID weir fishway

1. Movements of fish through the fishway were monitored from 16 April to 11 May 1985. Mountain whitefish were the predominant species, comprising 328 of 397 fish captured. Almost all of the mountain whitefish (97.6 percent) were upstream migrants. Only 11 rainbow trout were captured; 7 were upstream and 4 downstream migrants, respectively. The remaining fishway catch was comprised of longnose suckers (8.8 percent), white suckers (3.3 percent) and burbot (0.5 percent). The main direction of travel of coarse fish species was upstream (62.8 percent of longnose suckers, 61.5 percent of white suckers and 100 percent of burbot).

2. Boat electrofishing immediately below the weir on 11 May 1985 failed to produce any evidence of rainbow trout congregating below the weir, although relatively large numbers of mountain whitefish were found to do so (n = 342). These mountain whitefish may have been entrapped in pools below the weir and unable to find the fishway entrance, or they may have been induced to stay in these pools because the pools provided suitable feeding habitat.

3. It appeared that once fish reached the fishway entrance, conditions within the fishway were conducive to upstream movement. There was a dramatic reduction in fishway use, however, during the period of high flows when the LNID sluicegate was partially opened. Downstream migrants were likely swept down under the sluicegate, while upstream migrants would be probably attracted to the greater flows at the sluiceway, but unable to negotiate the high water velocities under the sluicegate.

5.4 Assessment of spring spawning activity upstream of the dam site

1. A boat float survey was conducted on 28 April 1985 on the Oldman River from Three Rivers bridge to the trap site (Figure 1). This section of river was deemed as having poor rainbow trout spawning habitat potential. Substrate was generally too coarse, although there did appear to be ample deep holding, and possibly overwintering pools for large salmonids. No adult trout or redds were observed.

2. High flows and turbid water conditions during 4 to 7 May 1985 precluded carrying out a similar survey on other upstream sections, so a boat electrofishing program was undertaken and the count of observed rainbow trout was used as a measure of the suitability of particular areas for spawning rainbow trout.

3. The lower Crowsnest River was the only section having significant numbers of adult rainbow trout, 235 rainbow trout were observed in the 9 km of river surveyed, and possibly, therefore, the only section having significant amounts of suitable spawning habitat within the study area. In contrast, only 2 rainbow trout were observed in 17.5 km of the Castle River, 7 individuals were counted in 9 km of the upper Oldman River from North Fork bridge to Cowley bridge, and no rainbow trout were observed in 13 km of the Oldman river from Cowley bridge to Three Rivers bridge.

4. Five of the seven rainbow trout sacrificed and examined for reproductive condition during the period 2 to 9 May 1985 were spent. Spawning activity may have initiated earlier than normal during 1985 due to atypically warm temperatures for the month of April. Furthermore, as significant numbers of rainbow trout were not captured at the LNID weir fishway during the 16 April to 11 May period, it appears that either most of the spawning rainbow trout are resident in the upper Oldman River system, or a major upstream migration past the LNID weir occurred before 16 April 1985.

6.0 LITERATURE CITED

Allan, J.H. 1985. Phase I Fisheries Overview, Ecological Component. Oldman River Dam Environmental Mitigation/Opportunities Plan. Pisces Environmental Consulting Services for Alberta Environment, Planning Division, Edmonton.

IEC Beak Consultants Ltd. 1984. Highwood River Instream Flow Needs Study (1983). Prepared for Planning Division, Alberta Environment, Edmonton.

_____. 1985a. Highwood River Instream Flow Needs Study (1984). Prepared for Planning Division, Alberta Environment, Edmonton.

_____. 1985b. Assessment of the LNID Diversion Headworks Fishway, Oldman River. Prepared for Planning Division, Alberta Environment, Edmonton.

O'Neil, J., L. Hildebrand, and T. Clayton. 1982. Fishery investigations related to the proposed Brocket Dam on the Oldman River. Prepared for Weasel Valley Water Use Study, Peigan Indian Band, and Alberta Environment by R.L. & L Environmental Services Ltd., Edmonton.

Radford, D.S. 1975. Oldman River flow regulation proposal. A preliminary study on the fish resources. Fish and Wildlife Division, Dept. of Recreation, Parks and Wildlife, Lethbridge. File Report.

Thompson, G.E. 1974. The ecology and life history of the mountain whitefish (Prosopium williamsoni Girard) in the Sheep River, Alberta. M.Sc. Thesis. University of Calgary, Calgary, Alberta.

Appendix 1.

Fish tagging information

(bound separately)

Appendix 2.

Stage (measured), velocity and discharge (from rating curves) for vertical slot 9, LNID weir fishway

Appendix 2. Stage (measured), velocity and discharge (from rating curves) for vertical slot 9, LNID weir fishway.

Date		Depth (m)	Vel (m/s)	Q (m^3/s)
April	16	0.49	0.73	0.065
/85	17	0.40	0.64	0.038
	18	0.38	0.61	0.033
	19	0.38	0.61	0.033
	20	0.36	0.58	0.026
	21	-	-	-
	22	0.44	0.69	0.050
	23	0.35	0.56	0.022
	24	0.40	0.64	0.038
	25	0.44	0.69	0.050
	26	0.29	0.46	0.015
	27	0.27	0.44	0.010
	28	-	-	-
	29	0.31	0.49	0.018
	30	0.38	0.61	0.033
May	1	0.39	0.63	0.035
/85	2	0.40	0.64	0.038
	3	0.51	0.75	0.070
	4	0.65	0.83	0.103
	5	0.47	0.72	0.059
	6	0.40	0.64	0.038
	7	-	-	-
	8	0.47	0.72	0.059
	9	0.47	0.72	0.059
n = 21		x = 0.412 s = 0.084	x = 0.0638 s = 0.097	x = 0.0424 s = 0.022

Appendix 3.

Site photographs

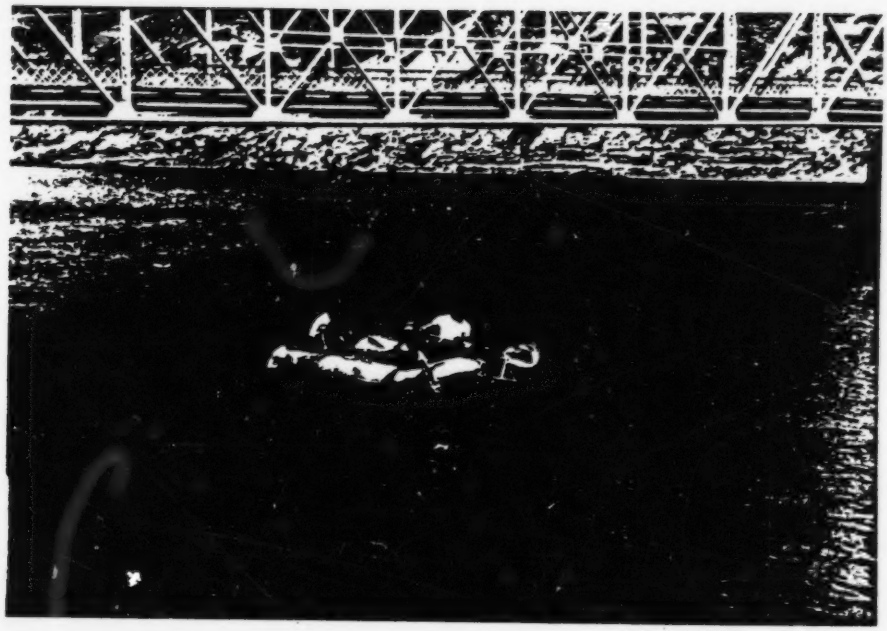

Plate 1. Boat electrofishing at Three Rivers Bridge on the Oldman River.

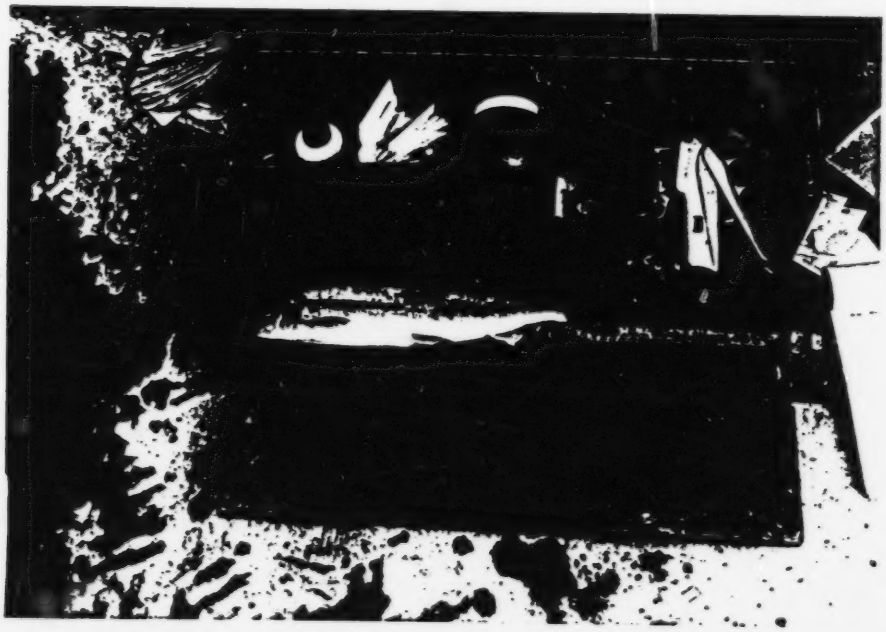

Plate 2. Mountain whitefish with numbered Alberta Environment Flov anchor tag.

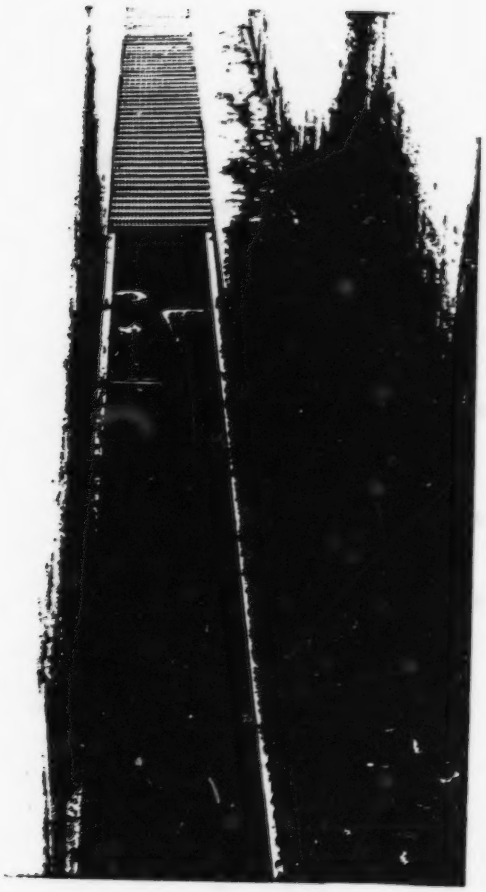

Plate 3. Trapping system at LNID weir fishway consisting of upstream-migrant trap (top), separator screen between pools (centre), and downstream - migrant trap (bottom).

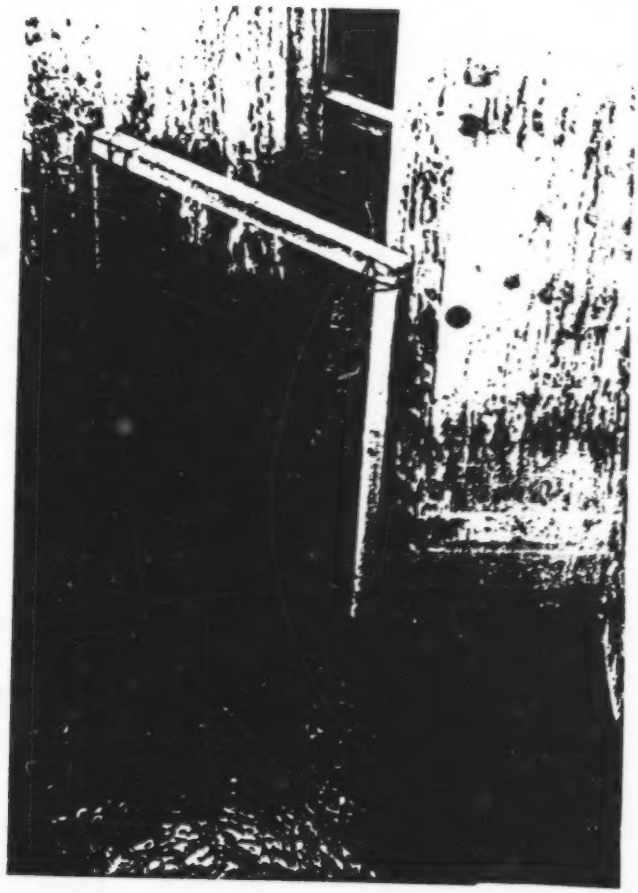

Plate 4. Funnel of downstream - migrant trap located in vertical slot at LNID weir fishway.

Plate 5. Upper Oldman River during spring flood conditions (4 May 1985).

Plate 6. Upper Oldman River during spring flood conditions (4 May 1985).

Plate 7. Crowsnest River during spring flood conditions (5 May 1985).

Plate 8. Crowsnest River during spring flood conditions (5 May 1985).

Plate 9. Castle River during spring flood conditions (6 May 1985).

Plate 10. Castle River during spring flood conditions (6 May 1985).

Plate 11. Oldman River between Cowley and Three Rivers Bridges during spring flood conditions (7 May 1985).

Plate 12. Oldman River between Cowley and Three Rivers Bridges during spring flood conditions (7 May 1985).

Plate 13. Oldman River at proposed Three Rivers dam site (28 April 1985).

Plate 14. Oldman River just upstream of proposed Three Rivers dam site (28 April 1985).